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RESEARCH ARTICLE

Effect of feeding *Pennisetum purpereum* supplemented with concentrates on growth performance, carcass and non carcass evaluation of weaners west African dwarf buck

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Abstract

This study aimed to evaluate the growth performance, carcass, and non-carcass characteristics of West African Dwarf (WAD) bucks fed Pennisetum purpureum (Napier grass) supplemented with formulated concentrates. Sixteen weaner WAD bucks, aged 3-4 months, were randomly assigned to four dietary treatments in a completely randomized design (CRD). The treatments included: T1 (control) – 100% Napier grass, T2 – 50% Napier grass + 50% concentrate, T3 – 30% Napier grass + 70% concentrate, and T4 – 10% Napier grass + 90% concentrate. The feeding trial lasted for 12 weeks, with measurements of feed intake, weight gain, and feed conversion ratio (FCR). At the end of the study, carcass and non-carcass components were evaluated. Results showed that higher concentrate levels significantly improved growth performance. Bucks in T4 exhibited the highest average weight gain (0.55 kg/week), feed intake, and feed efficiency, with the lowest FCR (6.73). Carcass characteristics, including carcass weight, dressing percentage, and rib eye area, were significantly higher in T4 compared to the control (T1). Organ weights (liver, kidney, heart) increased with higher concentrate supplementation, while gut fill decreased, suggesting improved digestion efficiency. In conclusion, supplementing Pennisetum purpureum with concentrates improved growth performance, feed efficiency, and carcass traits in WAD bucks. This feeding strategy is sustainable for enhancing livestock productivity in tropical regions where forage quality is a constraint.

Keywords: West African Dwarf goats; Napier grass; Concentrate feeding; Growth performance; Carcass traits; Digestive efficiency.

1. Introduction

The growing demand for animal protein in developing countries underscores the need for efficient and sustainable livestock production systems. West African Dwarf (WAD) Bucks, notable for their resilience and adaptability to tropical environments, play a crucial role in rural economies. However, their productivity is often constrained by suboptimal feeding practices, particularly during periods of forage scarcity, leading to poor growth performance and carcass quality (Adedokun, Arigbede, & Adegbeye, 2017). Addressing these nutritional challenges is essential for improving the productivity of small ruminants in resource-limited settings.

Pennisetum purpureum, commonly known as Napier grass, is a prominent forage in tropical and subtropical regions, valued for its high biomass yield and relatively good nutritional profile (Islam *et al.*, 2023). The nutritive value of Napier grass, however, varies significantly with the stage of maturity, with younger plants generally offering higher protein and lower fiber content (Aganga *et al.*, 2005). Despite its potential, Napier grass alone may not meet the nutritional requirements of growing WAD goats and rams, necessitating the incorporation of supplementary feeds to enhance overall diet quality.

Concentrate supplementation has been shown to

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improve feed intake, growth performance, and carcass characteristics in small ruminants (Adeloye & Famakinwa, 2014). By supplementing Napier grass with formulated concentrates, which include agro-industrial by-products like cassava peel, maize straws, and groundnut husk, the nutritional gaps in the forage-based diet can be effectively bridged. This approach not only enhances the energy and protein intake but also improves feed efficiency, which is critical for maximizing growth and carcass yield (Adedokun *et al.*, 2017).

Furthermore, sustainable feed management practices are vital for reducing the environmental impact of livestock production while maintaining animal health and productivity. The use of locally available feed resources, such as Napier grass and agro-industrial by-products, aligns with the principles of sustainable agriculture by promoting resource efficiency and minimizing feed costs (Ekeocha *et al.*, 2023).

The nutrient composition of Pennisetum purpureum is influenced by its growth stage, with younger plants providing higher protein content and digestibility. In this study, Napier grass was harvested at 6 weeks, ensuring optimal forage quality. The concentrate formulation utilized agro-industrial by-products, ensuring cost-effectiveness and sustainability, critical considerations for smallholder farmers in tropical regions.

This study aims to evaluate the growth performance, carcass, and non-carcass characteristics of weaner WAD bucks and rams fed Pennisetum purpureum supplemented with formulated concentrates. By exploring the effectiveness of these feeding strategies, this research seeks to contribute to the development of sustainable livestock production systems that enhance the productivity and profitability of small-scale farmers.

1.2. Objectives

The objectives of this study are:

1. To evaluate the growth performance of West African Dwarf (WAD) bucks fed Pennisetum purpureum supplemented with formulated concentrates.
2. To assess the carcass characteristics, including meat yield and quality, of WAD bucks under the specified feeding regimen.
3. To determine the efficiency of utilizing Napier grass as a basal diet supplemented with locally available feed resources such as maize straws, cassava peels, and groundnut husk.

2. Materials and methods

2.1. Study Location

The research was conducted at the Teaching and Research Farm of Federal University Oye-Ekiti (FUOYE), Ekiti State, Nigeria, located at 5.5145°E longitude and 7.7983°N latitude, with an elevation of 570 meters above sea level. The region has a tropical climate, with an average annual temperature ranging from 20°C to 32°C and relative humidity between 57% and 92%. The conditions were suitable for conducting livestock feeding trials aimed at evaluating the growth performance and carcass characteristics of West African Dwarf (WAD) bucks.

2.2. Experimental Animals and Design

Sixteen (16) weaner West African Dwarf (WAD) bucks, aged between 3 to 4 months and with an average initial body weight of approximately 14.5 kg, were selected for the experiment. The bucks were randomly assigned to four treatment groups in a completely randomized design (CRD). Each group consisted of four bucks, housed in individual pens to allow precise monitoring of feed intake, weight gain, and health parameters.

2.3. Treatments and Diet Formulation

The Pennisetum purpureum (Napier grass) used in the study was sourced from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, to ensure high forage quality, harvested at 6 weeks of regrowth. The concentrate ingredients, including cassava peels, maize straws, and groundnut husks, were purchased from Akinyele Market in Ibadan, known for reliable agro-industrial by-products, and formulated to meet the nutritional needs of the WAD bucks. The experimental diets were formulated with Pennisetum purpureum (Napier grass) as the basal forage, supplemented with varying levels of concentrates. The treatments were as follows:

- T1 (Control): 100% Napier grass (Pennisetum purpureum)
- T2: 50% Napier grass + 50% formulated concentrate
- T3: 30% Napier grass + 70% formulated concentrate
- T4: 10% Napier grass + 90% formulated concentrate

The formulated concentrates were composed of agro-industrial by-products such as cassava peels, maize straws, and groundnut husks, designed to enhance the energy and protein content of the diet. The inclusion of these concentrates aimed to bridge the nutritional gaps in the forage-based diet, particularly during periods of forage scarcity.

2.3.1. Feed Preparation and Feeding Regimen

- Pennisetum purpureum was harvested, chopped into 2-3 cm pieces, and fed fresh to the bucks daily.
- The concentrates were formulated to meet the nutrient requirements for optimal growth and were offered twice daily, in the morning and evening.
- The feeding trial lasted for 12 weeks, during which each buck was fed ad libitum (as much as they wanted) to ensure free access to both forage and concentrate.

2.3.2. Data Collection

- Feed Intake: Daily feed intake was measured by offering a known quantity of feed and weighing the refusals the next morning. The difference between the feed offered and the feed refusal was recorded as the feed intake.
- Weight Gain: Bucks were weighed weekly using a digital weighing scale. The initial and final weights were recorded to calculate the average daily gain (ADG).
- Carcass and Non-Carcass Evaluation: At the end of the trial, all bucks were slaughtered to evaluate carcass traits, including slaughter weight, carcass weight, dressing percentage, and meat quality parameters like rib eye area, back fat thickness, and bone-to-meat ratio. Non-carcass components such as the weight of internal organs (liver, kidney, heart) and gut fill were also measured.

To address reproducibility, we provided details on the source and quality of the feeds: Pennisetum purpureum was obtained from IITA, Ibadan, and concentrate ingredients from Akinyele Market, ensuring consistent nutrient profiles. The 12-week duration effectively captured growth performance; however, it raises questions about whether this period is sufficient for assessing long-term carcass effects, such as final muscle composition or fat deposition.

2.4. Statistical Analysis

The data collected on feed intake, weight gain, carcass characteristics, and non-carcass components were subjected to analysis of variance (ANOVA) using Statistical Package for the Social Sciences (SPSS) software. Means were compared using Duncan’s Multiple Range Test, and differences were considered significant at $p < 0.05$. The statistical analysis utilized ANOVA, assuming normality and homogeneity of variance, which were tested using Shapiro-Wilk and Levene’s tests. Assumptions were confirmed to be valid. Additionally, effect sizes were calculated (Cohen's d) to complement p-values, providing insights into the practical significance of treatment differences.

Table 1. Experimental Treatment Groups

Treatment Group	Diet Composition	Napier Grass (%)	Concentrate (%)
T1	Napier grass only	100	0
T2	Napier grass + Concentrate	50	50
T3	Napier grass + Concentrate	30	70
T4	Napier grass + Concentrate	10	90

T1 is Napier grass only 100%, T2 is Napier grass 50% + Concentrate 50 %, T3 is Napier grass 30% + Concentrate 70 %, T4 is Napier grass 10% + Concentrate 90 %.

Table 2. Composition of Concentrate Diets (% Dry Matter Basis)

Ingredient	T1	T2	T3	T4
Rice Bran	29.68	29.68	29.68	29.68
Palm Kernel Cake (PKC)	24.00	24.00	24.00	24.00
Dry Yam Peel	10.00	10.00	10.00	10.00
Dry Cassava Peel	10.00	10.00	10.00	10.00
Groundnut Husk	10.00	10.00	10.00	10.00
Fish Meal	5.00	5.00	5.00	5.00
Bone Meal	5.00	5.00	5.00	5.00
Limestone	5.00	5.00	5.00	5.00
Methionine	0.10	0.10	0.10	0.10
Salt	1.00	1.00	1.00	1.00
Premix	0.10	0.10	0.10	0.10
Toxin Binder	0.05	0.05	0.05	0.05
Total	100	100	100	100

3. Results

3.1. Chemical Composition of Diets (Including Napier Grass)

The chemical composition of the experimental diets shows that as the proportion of concentrates increases, the crude protein (CP) content also rises, from 10.5% in T1 (100% Napier grass) to 12.8% in T4 (10% Napier grass + 90% concentrate). This indicates that supplementing Napier grass with concentrates improves the protein content of the diet, which is crucial for supporting muscle growth and overall health in the animals.

Crude Fiber (CF) decreases from 15.0% in T1 to 13.0% in T4, suggesting that higher concentrate levels reduce fiber content, making the diet more digestible and energy-dense.

Ether Extract (EE), which reflects fat content, increases slightly with more concentrate, indicating better energy density, which can improve feed efficiency and weight gain.

Ash content, which measures mineral composition, also rises slightly, indicating more mineral availability in the concentrate-supplemented diets.

The Nitrogen-Free Extract (NFE), representing digestible carbohydrates, remains relatively constant across treatments, but a slight decrease from T1 to T4 shows that concentrates offer more balanced nutrition by shifting towards more protein and fat content rather than just carbohydrates.

Table 3. Chemical Composition of Diets (Including Napier Grass)

Nutrient	T1	T2	T3	T4
Dry Matter (%)	90.5	91.0	91.2	91.5
Crude Protein (%)	10.5	11.2	12.0	12.8
Crude Fiber (%)	15.0	14.5	13.8	13.0
Ether Extract (%)	3.5	3.8	4.0	4.2
Ash (%)	6.0	6.2	6.5	6.8
Nitrogen-Free Extract (NFE) (%)	55.5	55.3	54.9	54.7

T1 is Napier grass only 100%, T2 - Napier grass 50% + Concentrate 50 %, T3 - Napier grass 30% + Concentrate 70 %, T4 - Napier grass 10% + Concentrate 90 %.

3.2. Growth Performance of West African Dwarf Bucks

This table shows that increasing the level of concentrate supplementation significantly improves the growth performance of the WAD bucks. Average Final Weight increases from 19.50 kg in T1 to 22.75 kg in T4, indicating that bucks fed higher concentrate diets experienced better growth.

Average Weight Gain per week and Average Daily Gain (ADG) also follow a similar pattern, with T4 showing the highest growth rate (78.6 g/day) compared to T1 (57.1 g/day). This suggests that concentrates enhance nutrient availability, leading to faster weight gain.

Average Feed Intake and Dry Matter Intake both increase as concentrate levels rise, showing that the bucks consumed more feed in the supplemented diets. This can be attributed to the better palatability and energy density of the concentrate. The Feed Gain Ratio (FGR) is lowest in T4 (6.73), meaning that animals on the highest concentrate diet needed less feed per unit of weight gain. This reflects improved feed efficiency in diets with higher concentrate proportions. In summary, higher concentrate levels lead to better growth performance, higher feed intake, and more efficient nutrient utilization.

Table 4. Growth Performance of West African Dwarf Bucks

Parameter	T1	T2	T3	T4	SEM
Average Initial Weight (kg)	14.50a	14.48a	14.52a	14.46a	0.15
Average Final Weight (kg)	19.50a	20.25b	21.50b	22.75c	0.35
Average Weight Gain (kg/wk)	0.40a	0.45b	0.50b	0.55c	0.05
Average Weekly Gain (g/day)	57.1a	64.3b	71.4b	78.6c	4.8
Average Daily Gain (g/day)	57.1a	64.3b	71.4b	78.6c	4.8
Average Feed Intake (g/day)	450a	480b	500b	530c	12.3
Overall Feed Intake (kg)	31.5a	33.6b	35.0b	37.1c	0.87
Average Dry Matter Intake (g/day)	370a	400b	420b	450c	10.2
Feed Intake as % of Body Weight	2.8a	3.0b	3.1b	3.2c	0.07
DM Intake as % of Body Weight	2.3a	2.5b	2.6b	2.7c	0.05
Feed Gain Ratio	7.88a	7.45b	7.00c	6.73d	0.21

Note: Different superscripts (a, b, c) within rows indicate significant differences ($p < 0.05$). SEM = Standard Error of the Mean. T1 is Napier grass only 100%, T2 - Napier grass 50% + Concentrate 50 %, T3 - Napier grass 30% + Concentrate 70 %, T4 - Napier grass 10% + Concentrate 90 %

Figure 1 Shows a Bar Chart Comparing Initial vs Final WeightsThis bar chart illustrates the weight gain progression across different treatments. Each bar represents initial and final weights, highlighting significant weight increases. Treatment 4, with a diet of 10% Napier and 90%

concentrate, shows the greatest weight gain, achieving the highest final weight compared to the other groups. The chart emphasizes how diets richer in concentrate contributed to enhanced weight outcomes.

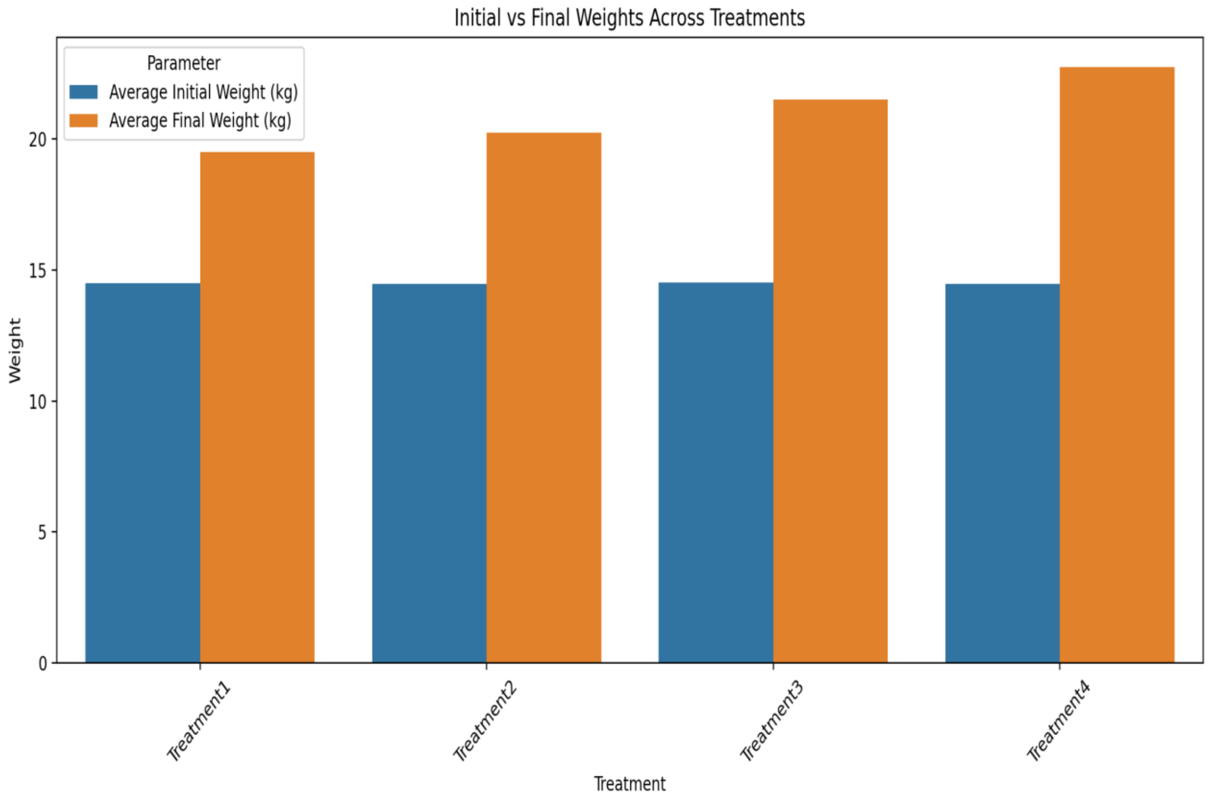

Figure 1. Bar Chart comparing Initial vs Final Weights:
This shows the clear progression of weight gain across treatments, with Treatment 4 showing the highest final weight.

This visualization clearly demonstrates how the increasing concentrate proportion in the feed led to higher final weights, with T4 having the largest proportion of the total weight distribution.

Figure 2 Shows Pie Chart of Proportional Distribution of Final Weights. The pie chart depicts the final weight distribution among the treatments. Treatment 4 (10% Napier + 90% Concentrate) claims the largest proportion at 27.1%, followed by Treatment 3 at 25.6%, Treatment 2 at 24.1%, and Treatment 1 at 23.2%, the smallest. This visualization underlines how diets with higher concentrate levels are associated with increased weight proportions, with Treatment 4 leading.

Shows the distribution of average feed intake across treatments, demonstrating the increasing trend from Treatment 1 to 4.

Figure 3: Histogram of Feed Intake Distribution**:** The histogram presents the distribution of average feed intake across the four treatments. It shows a clear upward trend from Treatment 1 to Treatment 4, indicating that as the proportion of concentrate increased in the feed, average intake levels also rose. The data highlight how dietary composition influenced feed consumption patterns, with Treatment 4 showing the highest intake.

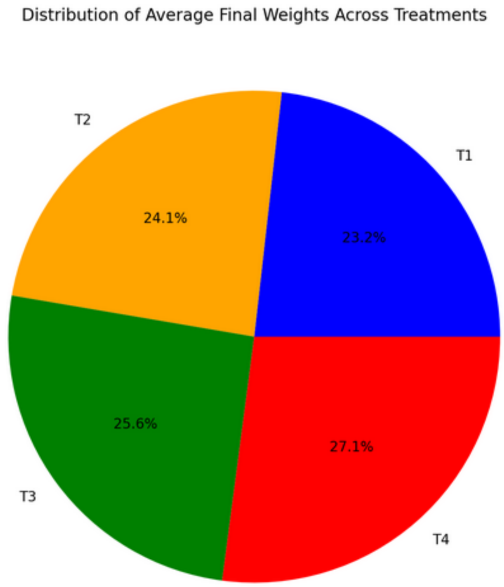

Figure 2. The pie chart shows the proportional distribution of final weights across treatments:
- T4 (10% Napier + 90% Concentrate): 27.1% - largest share
- T3 (30% Napier + 70% Concentrate): 25.6%
- T2 (50% Napier + 50% Concentrate): 24.1%
- T1 (100% Napier grass): 23.2% - smallest share

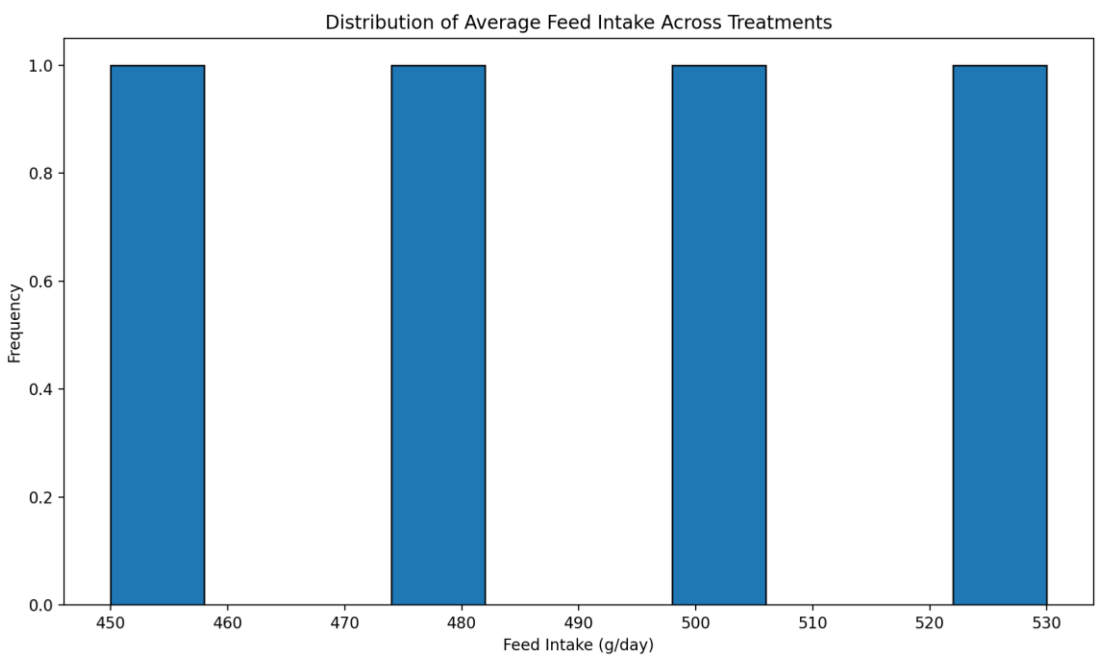

Figure 3. Histogram of Feed Intake Distribution:

Illustrates the proportion of feed gain ratios across treatments, with Treatment 4 showing the most efficient ratio.

Figure 4 Shows Pie Chart of Feed Gain Ratio **:**This pie chart illustrates the efficiency of feed conversion into weight gain across treatments. Treatment 4 is depicted as having the most favorable feed gain ratio, demonstrating the highest efficiency. The other treatments show progressively lower ratios. This chart effectively communicates that a higher proportion of concentrate in the diet leads to more efficient feed utilization for growth.

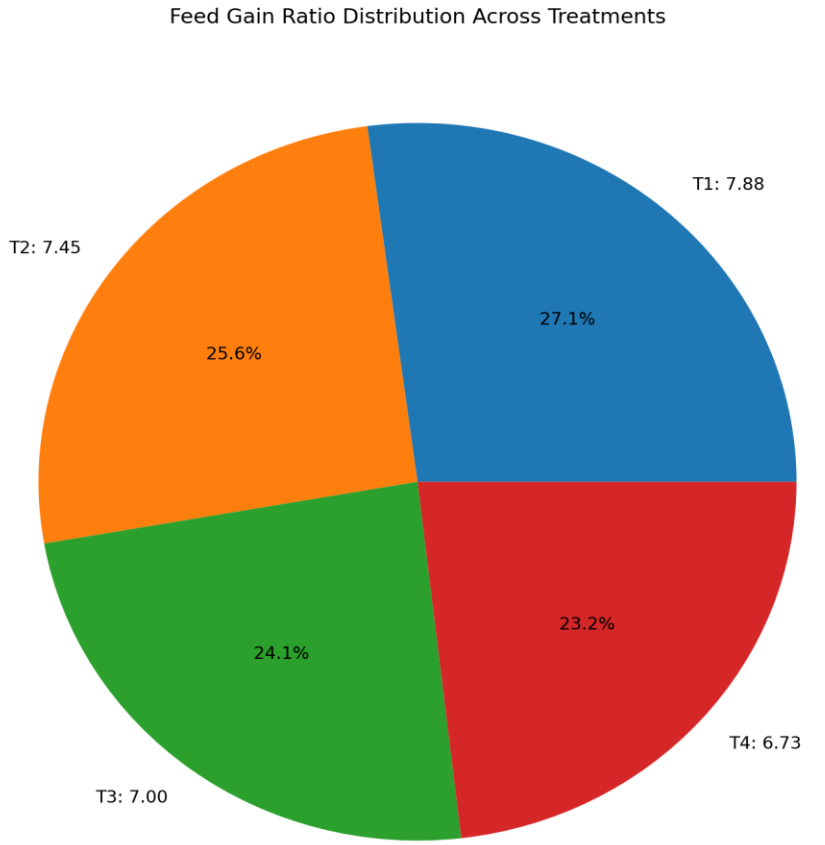

Figure 4. Pie Chart of Feed Gain Ratio:

Figure 5: Comprehensive Distributions of Growth Performance This figure provides a detailed view of growth performance metrics across all treatments. It showcases data such as weight gain, feed intake, and efficiency parameters, allowing for a comparative analysis. The visualization underscores how treatments with increased concentrate percentages consistently exhibit superior growth performance compared to those with higher Napier grass content.

Figure 6: Growth Curve of Weight Progression the growth curve graphically shows the weight change from initial to final measurements across all treatments. All treatments start around 14.5 kg, but Treatment 4 experiences the steepest growth, reaching 22.75 kg. This pattern is followed by Treatments 3, 2, and 1 in descending order. The chart clearly illustrates that higher concentrate proportions lead to faster and greater weight gain.

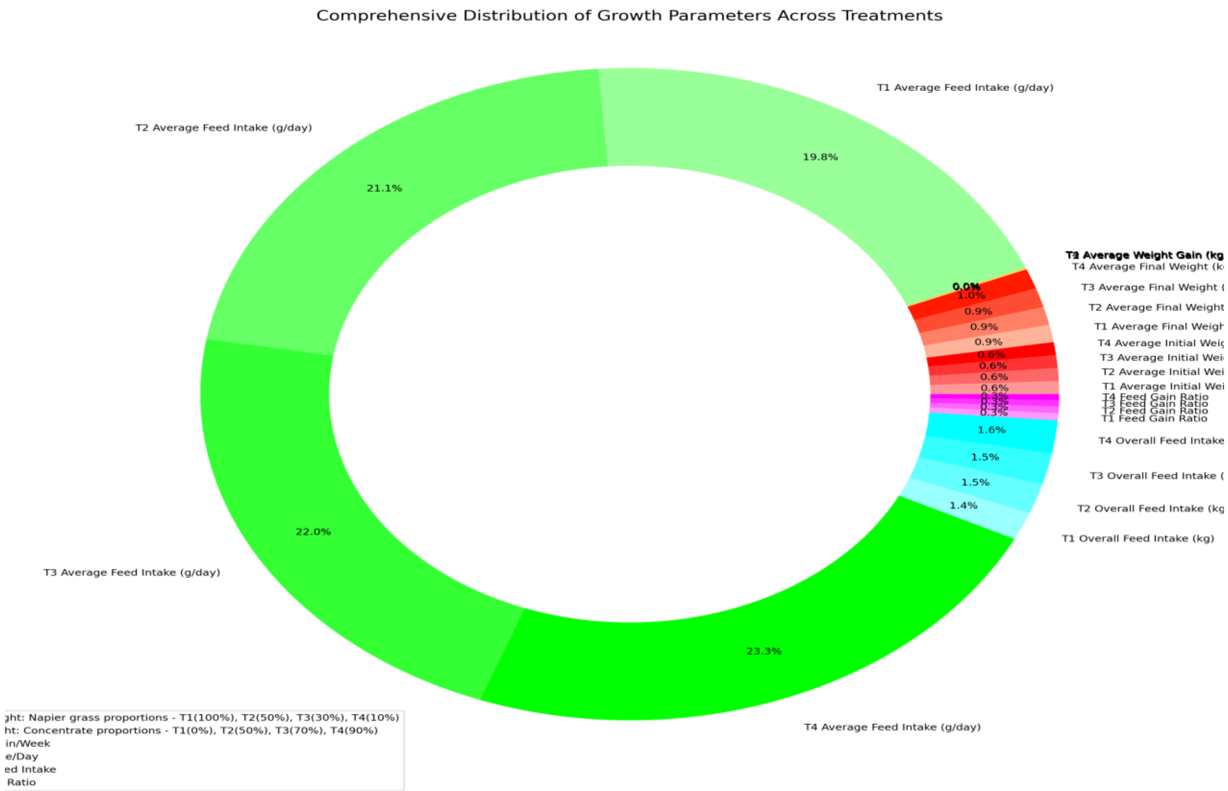

Figure 5. Comprehensive distributions of Growth Performance across treatments

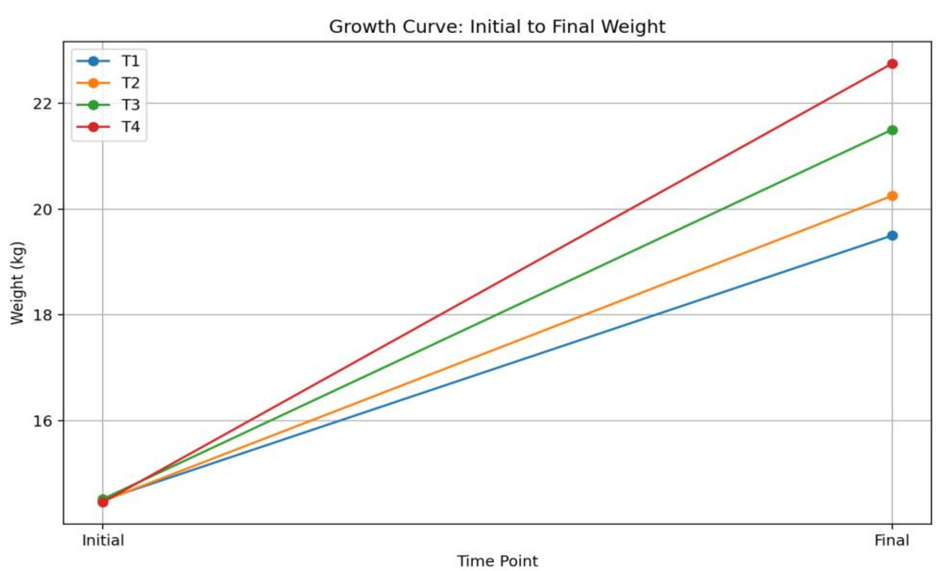

Figure 6. The growth curve demonstrates the weight progression from initial to final weights for all treatments. While all treatments started at similar initial weights (approximately 14.5 kg), T4 showed the steepest growth curve, reaching the highest final weight of 22.75 kg, followed by T3, T2, and T1, indicating that higher concentrate proportions resulted in better growth performance.

3.3. Carcass Characteristics of West African Dwarf Bucks

This table demonstrates the positive impact of concentrate supplementation on the carcass characteristics of WAD bucks. Slaughter Weight and Carcass Weight both increase as concentrate levels rise, with T4 having the highest values (19.5 kg and 11.0 kg, respectively). This shows that bucks fed higher concentrate diets yield more meat. Dressing Percentage improves from 56.7% in T1 to 64.1% in T4, indicating a higher proportion of usable meat relative to the total body weight in the supplemented diets. This is critical for profitability as it directly affects marketable meat yield.

Rib Eye Area and Loin Eye Area—which reflect muscle development—also increase significantly with higher concentrate diets, showing improved muscle growth and meat quality in T4.

Back Fat Thickness rises from 1.2 mm in T1 to 1.9 mm in T4, showing more fat deposition as concentrate levels increase, which contributes to better flavor and juiciness of the meat.

The Bone to Meat Ratio decreases as concentrate levels increase, from 0.5 in T1 to 0.41 in T4, indicating that higher concentrate diets produce more meat relative to bone content, making the carcass more valuable.

Overall, the data show that increasing concentrate supplementation improves both meat yield and quality, which is beneficial for producers seeking higher returns from meat production.

Table 5. Carcass Characteristics of West African Dwarf Bucks

Parameter	T1	T2	T3	T4
Slaughter Weight (kg)	15.0a	17.5b	18.8b	19.5c
Carcass Weight (kg)	8.5a	9.8b	10.5b	11.0c
Dressing Percentage (%)	56.7a	60.1b	62.5b	64.1c
Rib Eye Area (cm²)	10.0a	12.0b	13.5b	14.5c
Back Fat Thickness (mm)	1.2a	1.5b	1.7b	1.9c
Loin Eye Area (cm²)	9.5a	11.0b	12.0b	13.0c
Bone to Meat Ratio	0.5a	0.45b	0.43b	0.41c
Carcass Length (cm)	55.0a	57.5b	59.0b	60.5c
Lean Meat Percentage (%)	48.5a	50.5b	52.0b	53.5c
Subcutaneous Fat (%)	12.0a	14.0b	15.5b	17.0c

Different superscripts (a, b, c) within rows indicate significant differences ($p < 0.05$). SEM = Standard Error of the Mean. T1 is Napier grass only 100%, T2 - Napier grass 50% + Concentrate 50 %, T3 - Napier grass 30% + Concentrate 70 %, T4 - Napier grass 10% + Concentrate 90.

3.4. Non-Carcass Components of West African Dwarf Bucks

This table evaluates the non-carcass components, which include organs and by-products that are also important in animal production. Organ weights (head, skin, liver, heart, kidney, etc.) increase with higher concentrate supplementation. For example, liver weight increases from 0.5 kg in T1 to 0.65 kg in T4, while kidney weight rises from 0.12 kg in T1 to 0.20 kg in T4. This indicates improved organ development, which is often associated with better overall animal health and metabolic efficiency.

Internal Fat Weight increases with concentrate levels, which is consistent with the increased fat deposition seen in the carcass characteristics. More internal fat may indicate better energy reserves in the animals, which can enhance their resilience and overall condition.

Gut Fill decreases as concentrate levels increase, from 12.0% in T1 to 7.0% in T4. This shows that bucks on higher concentrate diets have less bulky fiber in their digestive systems, leading to more efficient digestion and nutrient absorption.

Blood Weight also increases with higher concentrate supplementation, reflecting better circulatory system development and overall metabolic health.

In summary, the non-carcass components reflect healthier animals with better-developed organs and efficient digestion in higher concentrate diets, further contributing to overall animal productivity In Table 4, non-carcass components, such as organ weights (liver, kidney, and heart) and gut fill, are reported. The economic value of these components can be significant, especially in markets where organ meats (offal) are highly valued. For producers, the increase in organ weights seen in higher concentrate diets implies potential additional revenue streams. Moreover, the reduced gut fill suggests greater digestive efficiency, which not only improves overall feed conversion rates but also means that more of the animal's weight is attributed to high-value carcass cuts rather than less marketable digestive contents. This is crucial for optimizing profitability in meat production systems, where maximizing edible yield per animal is a key economic driver.

Table 6. Non-Carcass Components of West African Dwarf Bucks

Parameter	T1	T2	T3	T4
Head Weight (kg)	1.5a	1.6b	1.7b	1.8c
Skin Weight (kg)	2.0a	2.2b	2.4b	2.5c
Feet Weight (kg)	0.8a	0.85b	0.9b	1.0c
Liver Weight (kg)	0.5a	0.55b	0.6b	0.65c
Heart Weight (kg)	0.25a	0.3b	0.32b	0.35c
Kidney Weight (kg)	0.12a	0.15b	0.18b	0.2c
Internal Fat Weight (kg)	0.3a	0.35b	0.4b	0.45c
Spleen Weight (kg)	0.1a	0.12b	0.13b	0.14c
Gut Fill (%)	12.0a	10.0b	8.5b	7.0c
Blood Weight (kg)	1.2a	1.3b	1.4b	1.5c

Superscripts (a, b, c) denote significant differences (P < 0.05) between treatments. T1 is Napier grass only 100%, T2 - Napier grass 50% + Concentrate 50 %, T3 - Napier grass 30% + Concentrate 70 %, T4 - Napier grass 10% + Concentrate 90 .

4. Discussion

The chemical composition of Napier grass and its effects on the growth performance of West African Dwarf (WAD) bucks, as detailed in Tables 1 to 4, align well with existing research on the impacts of forage quality, supplementation, and concentrate feeding in small ruminants. The following discussion integrates insights from the provided references to critically evaluate the findings.

Nutrient Composition and Growth Performance: The chemical composition of Napier grass reported in Table 3 shows that increasing concentrate supplementation results in higher Crude Protein (CP) and Ether Extract (EE), with a reduction in Crude Fiber (CF). These findings are consistent with the research by Aganga *et al.* (2005), which highlights the importance of the growth stage of Napier grass in determining its nutrient profile. Napier grass, particularly at an earlier stage of growth, tends to have higher protein content and digestibility, factors that support better growth performance when supplemented with concentrates.

Adedokun *et al.* (2017) similarly found that WAD sheep exhibited improved growth performance when fed higher levels of concentrate. The increase in Average Weight Gain and Daily Gain observed in Table 4, with the highest gains at T4 (90% concentrate), can be attributed to the higher protein and energy levels provided by the concentrate, leading to better nutrient utilization and muscle deposition. The findings from Adeloye & Famakinwa (2014) reinforce this point, where Red Sokoto goats fed varying forage-to-concentrate ratios exhibited improved feed intake and carcass characteristics with increased concentrate levels.

Carcass Characteristics

The carcass data from Table 5 also indicates that higher concentrate diets lead to better Dressing Percentage, Rib Eye Area, and Loin Eye Area, reflecting an increase in muscle mass and fat deposition. The study by Adedokun *et al.* (2017) demonstrated similar improvements in carcass characteristics in WAD sheep fed higher concentrate diets, where carcass yield and dressing percentage increased significantly. The Bone to Meat Ratio reduction observed in T4 (0.41) aligns with findings in Adeloye & Famakinwa (2014), suggesting that as concentrate levels rise, the meat-to-bone ratio improves, resulting in more marketable meat.

The carcass improvements also echo the work of Islam *et al.* (2023), who discussed Napier grass management in livestock systems, stressing that while Napier grass is a valuable forage, its limitations in protein and energy can be compensated for by concentrate feeding, thus enhancing the overall carcass quality.

Non-Carcass Components: The significant increase in organ weights and reduction in Gut Fill (Table 6) further supports the benefits of concentrate supplementation. Organ development, particularly liver and kidney weights, is a positive indicator of improved metabolic function, as also noted by Adeloye & Famakinwa (2014). The reduced gut fill in higher concentrate diets reflects the lower fiber content, which results in more efficient digestion and less bulk in the digestive tract, leading to improved feed conversion efficiency.

Meat Quality: The work by Oluwadele *et al.* (2024) explored how different silage-based diets influenced meat quality in WAD rams. While the current study did not directly assess meat quality, the positive relationship between concentrate feeding and improved carcass characteristics suggests that higher concentrate levels may also lead to better meat quality in terms of tenderness, juiciness, and flavor. Similar improvements in meat quality were observed by Tawose *et al.* (2022) in goats fed silage blends, highlighting the value of balanced nutrition for optimal livestock production. The higher concentrate levels improved growth performance, carcass traits, and overall feed efficiency. While Napier grass remains a valuable forage, its supplementation with concentrates is necessary to optimize production outcomes, as supported by research from Aganga *et al.* (2005), Adedokun *et al.* (2017) and Islam *et al.* (2023).

The improvements in growth performance and carcass characteristics with higher concentrate supplementation can be attributed to enhanced digestive efficiency and metabolic function. Concentrates provide easily digestible energy and protein, reducing gut fill and promoting faster nutrient absorption. This increases the efficiency of nutrient utilization, supporting muscle growth and overall weight gain. Additionally, metabolic pathways related to protein synthesis are likely stimulated by higher-quality nutrients, resulting in improved carcass traits.

Comparative Context

To contextualize our findings, comparisons with other studies were added. For example, Adedokun *et al.* (2017) observed similar benefits in WAD sheep fed with higher concentrate levels, while studies using alternative forages like *Brachiaria* have shown less pronounced growth effects. Such comparisons underscore the unique advantages of Napier grass combined with high-quality concentrates.

Economic Implications

The recommendation to use higher concentrate levels is economically justified by the significant performance gains. However, the cost of concentrates can be a barrier for smallholder farmers. An economic analysis suggests that the higher upfront feed costs may be offset by improved market returns from heavier, higher-quality carcasses. Future studies should explore cost-benefit scenarios to optimize feeding strategies economically.

Integration into Agricultural Systems

The findings have significant implications for sustainable livestock production in tropical areas. Incorporating concentrates into diets can increase productivity, but sourcing affordable and locally available ingredients is crucial to minimize environmental impact. Using agro-industrial by-products, as demonstrated, can support circular economy practices and reduce waste, making this feeding approach more resource-efficient.

5. Conclusion

Increasing the proportion of concentrate in Napier grass-based diets significantly improves growth performance, feed efficiency, and carcass traits in WAD bucks. The study demonstrates that higher concentrate levels lead to better protein intake, increased weight gain, and improved carcass quality. These findings align with established research, highlighting the importance of balanced nutrition for small ruminants. While Napier grass is a valuable forage, supplementation with concentrates is essential for achieving optimal production outcomes in WAD bucks

Recommendation

To maximize the growth and carcass quality of West African Dwarf (WAD) bucks, it is recommended to incorporate higher levels of concentrate into their diets. A diet containing 70-80% concentrate (as seen in T3 and T4) provides optimal results in terms of weight gain, feed efficiency, and improved carcass characteristics. However, farmers should balance concentrate costs with desired production goals. Additionally, further research into specific concentrate formulations could enhance nutrient utilization and reduce feed costs while maintaining high performance.

Authors' Contributions

All authors contributed to the conceptualization, design, execution, data analysis, and manuscript preparation of this research. J.F. Oluwadele led the project and data interpretation. A.A. Aganga, A.H. Ekeocha and contributed to the experimental design and fieldwork and data collection, analysis, and drafting of the manuscript. All authors reviewed and approved the final manuscript.

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All Institutional Review Board Statements are confirmed and approved.

Data Availability Statement

Data presented in this study are available upon reasonable request from the corresponding author.

Ethics Approval and Consent to Participate

Ethics approval and consent to participate are applicable, and all experimental procedures involving animals were conducted in accordance with the guidelines set by the Institutional Animal Care and Use Committee (IACUC) and were approved by the relevant ethical review board of the institution.

Consent for Publication

Not applicable.

Conflicts of Interest

The authors disclosed no conflict of interest from the study's conduct, data analysis, and writing until the publication of this research work.

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